tion, about one-half were accompanied by nearly synchronous changes at the base stations; one-third were followed within 48 hours by lower minimum temperatures at the base stations; one-fifth were followed by a slight rise of temperature at the base stations.

In the instances where cold waves on the summit precede those at the base, particularly those where a rise of temperature occurs at the base, the cause is probably local gradients less steep than usual, mechanical cooling of the air at the summit during a strong wind, or clouds or fog in the valleys and below the summit. Such a condition, however, does not appear to be a very stable one and probably can not exist very long.

Abnormal falls of temperature or cold waves occur most frequently when a cyclone or area of low pressure is about 500 miles south or southeast, and an anticyclone or area of high pressure about 300 miles northwest of Mount Rose.

When well-defined cyclones and anticyclones pass over or near Mount Rose, the changes of temperature at the summit and base are nearly synchronous, for at such a time the winds at all levels are higher than normal and the atmosphere more nearly homogeneous.

It is believed that data from high-level stations will be found valuable in local forecasting when studied with reference to the prevailing meteorological conditions, as shown by the daily weather maps. However, since the processes of the free atmosphere are not as yet fully understood, particularly in this region where no systematic aerological exploration has been made, it will be necessary first to determine the vertical gradients or distribution of the chief meteorological elements by means of recording instruments elevated by kites and balloons and from observations of the formation and movements of clouds. This work should be done in some level region, such as the Carson Sink, where the phenomena of the free atmosphere are not influenced by neighboring mountains or valleys. Comparisons of free-atmosphere data with observations on mountains and in valleys under various conditions of weather will show the relation of local phenomena to the general movements of the atmosphere.

Practical use of the results of an investigation of this kind can be made by embodying the information in courses of study, and in publications, so that, in time, the residents of any community familiar with local conditions and having access to the daily weather maps will be able to make local forecasts more accurate than those based upon local or general data alone.

The writer believes that the local weather maps could be improved by the use of data from a larger number of stations and by reducing the data to the average level of the region as well as to sea level, for thereby where changes of pressure are small the effects of errors of reduction will be lessened. Further improvement could be effected by adopting the plan of the International maps wherein the pressures are published in C. G. S. units, so that the pressure at any level is a direct percentage of the entire standard atmosphere near sea level.

The Weather Bureau is rendering an important service in publishing maps, forecasts, and general information for the benefit of agriculture, and this can be made much more effective if our agricultural colleges and stations cooperate with courses of instruction and intensive investigation of problems of local interest.

AEROLOGICAL OBSERVATIONS DURING AIRPLANE FLIGHT ABOVE HAWAIIAN ISLANDS.

[Abstract of report by Lawrence H. Daingerfield, Meteorologist, Weather Bureau, Honolulu, Hawaii.]

This flight was made from Luke Field, Oahu, Hawaii, between 11 and 11:45 a. m., February 25, 1920. Readings of a sling psychrometer were made for each thousand feet during the ascent and descent, and cloud and wind conditions were also noted. Altitudes were those indicated by a standard altimeter, no corrections being applied for mean temperature of the air column.

A light westerly wind prevailed at the surface; this gave way at a low altitude to the northeast trade wind, which in t rn was displaced by a strong west wind (antitrade) at an altitude of about 11,000 to 12,000 feet.

Cumulus clouds were entered at an altitude of 3,000 to 4,000 feet; above these clouds the sky was partially obscured by alto cumulus and a veil of alto stratus from the west.

Psychrometric observations were made by exposing the dry and wet bulb thermometers to the air rushing by the upper left-hand surface of the fuselage. These observations showed decreasing temperatures and relative humidities to the base of the cumulus; a continued temperature decrease and a rise in humidity from that level to the top of the cumulus; a temperature inversion and very low humidity during the next 2,000 feet; and decreasing temperatures, accompanied by increasing humidities, from about 8,000 feet to the highest altitude reached.

So far as known, these are the first free-air meteorological observations ever made above the Hawaiian Islands.—*W. R. G.*

ALTITUDE DETERMINATIONS BASED ON BAROMETRIC READINGS.

By H. G. CORNTHWAITE, Acting Chief Hydrographer.

[Balboa Heights, Canal Zone, Mar. 16, 1920.]

Under favorable conditions very accurate altitude determinations can be made from simultaneous barometric readings, especially in the Tropics where air-pressure fluctuations are small.

Up to elevations of 5,000 or 6,000 feet a mercurial barometer is preferable to an aneroid for this work if closely accurate results are desired; at higher levels it will probably be necessary to use an aneroid, which should give satisfactory results if the instrument used is a good one, but it should first be carefully tested covering the expected range in pressure readings. Few aneroids can be depended upon to give as accurate readings over a wide range in pressure as a good mecurial barometer. The aneroid may read accurately at sea level, but be off several hundredths of an inch at an elevation of 5,000 feet. When it is recalled that an error of 1/100 inch is equivalent to about 10 feet difference in altitude, it will be seen that an error of a few hundredths inch in the aneroid reading may mean a considerable error in the altitude determination.

A "Mountain" mercurial barometer equipped with carrying case and tripod is a convenient instrument to use for topographic reconnaissance work at moderate elevations, and it will give better results than most aneroids (see plate No. 1).

Best results are obtained when simultaneous readings are made at a near-by station of known elevation at the base of the hill or mountain.

The average of three or more simultaneous readings taken at 15 minutes or half hour intervals ordinarily will give better results than can be obtained from single readings.

If the base station is located near by and all readings are accurately made it should be possible to figure the difference in elevation very closely, using reduction tables such as those published in "Smithsonian Meteorological Tables." It is important to record the attached thermometer and shade air temperatures also, for use in correcting and reducing the readings.

In the Tropics where the air is warm and light one inch difference in air pressure is equivalent roughly to 1,000 feet difference in altitude, while in the temperate zone where the air is cooler and denser an inch difference in pressure may equal only 850 or 900 feet difference in altitude. For this reason the arbitrary fixed altitude scales on aneroids are not reliable for varying temperature conditions.

If it is not possible to take simultaneous readings at a near-by base station, the pressure at the lower station must be estimated. Under these conditions less accurate results will be obtained.

The accompanying plate (No. 2) shows typical winter pressure curves for temperate zone and tropical climates. The large irregular pressure fluctuations in the temperate zone make it extremely difficult to determine elevations accurately from barometric readings unless simultaneous readings at a near-by base station can be made.

In the Tropics the barometric pressure is so constant, except for regular, well-marked diurnal fluctuations, that the sea-level pressure can be estimated closely, and fairly good altitude determinations can be made without taking simultaneous pressure readings at a near-by base station.

The following results were obtained in the Canal Zone, elevations being determined from the average of six mercurial barometer readings taken simultaneously at the upper and lower stations.

Station.	Elevation by barometer.	Actual elevation by triangulation.
	Feet.	*Feet.*
Ancon Hill	659	654
Cerro Gordo	965	972

It will be seen that the elevations obtained by barometer were off less than 1 per cent (assuming the elevations by triangulation to be correct).

Individual readings varied but slightly from the mean of all readings, as may be seen from the following table:

Time.	Corrected station pressure.		Indicated difference.	Indicated altitude of Ancon Hill.[1]
	Ancon.	Ancon Hill.		
	Inches.	*Inches.*	*Feet.*	*Feet.*
1:45 p. m.	29.638	29.078	562	654
2:00 p. m.	29.641	29.077	568	660
2:15 p. m.	29.641	29.078	567	659
2:30 p. m.	29.640	29.071	573	665
2:45 p. m.	29.641	29.083	559	651
3:00 p. m.	29.638	29.069	573	665
3:15 p. m.	29.631	29.067	565	657
Average of all readings				659

[1] Difference in feet plus 92 feet (elevation of Ancon Station).

These determinations were made under the most favorable conditions, the base station at Culebra being not more than 2 miles distant from Cerro Gordo, and the base station at Ancon less than a mile distant from Ancon Hill. Actual field work would often have to be performed under less favorable conditions, with base stations farther distant or unavailable, in which case less accurate results would be obtained.

COMPARISON OF SNOW-BOARD AND RAINGAGE-CAN MEASUREMENTS OF SNOWFALL.

By ROBERT E. HORTON.

[Voorheesville, N. Y., Mar. 17, 1920.]

The unusual accumulation of snow in eastern New York afforded an opportunity for comparison of the accuracy of measurements of snowfall by two different methods in common use. The rain gage overflow can and the snow board were both exposed on the ice near the center of a pond at the author's laboratory, the pond being about 100 feet wide and several hundred feet in length, in an easterly and westerly direction. The north slope to the pond ranges from 10 to 20 feet per hundred, and the pond is bordered on the north by occasional trees and brush. The south bank is abrupt and wooded. Snow drifts on the pond surface only on rare occasions.

The snow board used was that devised by the author, consisting of a sheet of white beaver board, about 16 inches square, with a layer of cotton flannel tacked on to the surface of the beaver board, nape uppermost. After each reading was taken, the snow board was cleaned and dried, and laid on the surface of the newly fallen undisturbed snow. In all the storms recorded in the table, the snow fell mainly during wind, and at a large angle to the vertical, often approaching the horizontal.

Comparing the results as shown in column 5, it will be noted that the average depth of snowfall, as determined by the water equivalent, is 16 per cent more than that determined from measurements taken in the overflow can of the rain gage. In taking the readings, the gage can was first weighed, the snow then removed therefrom, and a sample cut out of the snow on the snow board by inverting the gage can over the snow board, like a cookie cutter, then picking up gage can and snow board together, so as to get a perfect sample in the gage can. The gage can was then again weighed. An accurate torsion balance was used, making possible in all cases to determine the water equivalent of the snow to the nearest thousandth of an inch of water.

It will be noted that in very light snow flurries, the amount caught on the snow board might be equal to or less than that caught in the gage can. In all heavier snows, the catch on the snow board was greater, and by a fairly consistent percentage. Much of this snow fell when the temperature was about 32°, and while the type of snow board used was specially designed to simulate a snow surface, and prevent melting, the results indicate that in very light snow flurries the snow board may give deficient results. The most significant result is, however, the fact that for two months taken as a whole, the excess indicated by the snow board is 16 per cent as compared with gage-can measurements. This on a total winter's snow precipitation of 12 inches amounts to roundly 2 inches, a fact which, if generally true, helps to afford an explanation of the apparent deficiency of winter water losses, often observed by comparison of precipitation and runoff on streams where the runoff records appear to be above suspicion.